Sustainable grape and wine production
in the context of climate change
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# How do rootstocks control scion water use efficiency ?

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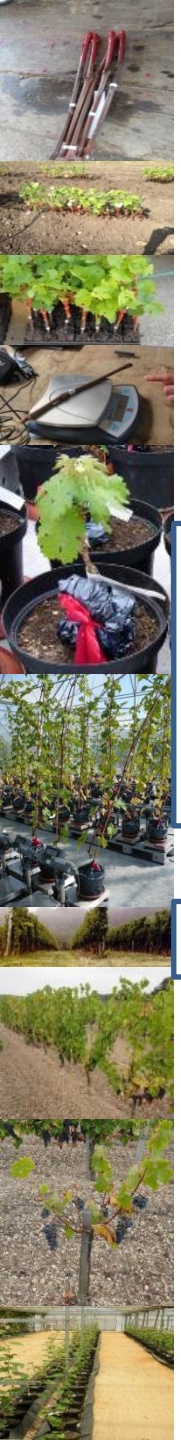


# Introduction

- "The lesser- known half of the perennial crop equation"

Reviewed in Warschefsky et al., 2016

| Scientific Name | Common Name | Family | Targeted Trait | Refs |
|---|---|---|---|---|
| *Spondias dulcis* Parkinson | Ambarella | Anacardiaceae | None known | [148] |
| *Tamarindus indica* L. | Tamarind | Fabaceae | None known | [148,207] |
| *Theobroma cacao* L. | Cocoa | Malvaceae | Yield | [208–210] |
| *Vaccinium* spp. | Blueberry | Ericaceae | Precocity, scion vigor | [211] |
| ***Vitis vinifera* L.** | Grape | Vitaceae | Drought tolerance | [41,51,52,212,213] |
| *Ziziphus* spp. | Jujube | Rhamnaceae | None known | [148] |

- Rootstock effect on growth and biomass accumulation

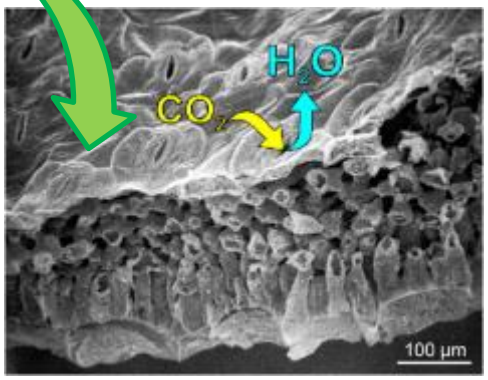
(Tandonnet et al., 2008)

and scion gas exchange (A & g) (Carbonneau 1985 ; Düring, 1994)

and water use efficiency (Iaconno et al, 1998 ; Padgett Johnson et al, 2000)

# Water use efficiency

- Ratio of A/g
- Estimated with $\delta^{13}C$ (‰)




$^{13}C$ $^{12}C$ $^{12}C$ $^{12}C$ $^{12}C$ → Low $\delta^{13}C$ as -28 ‰

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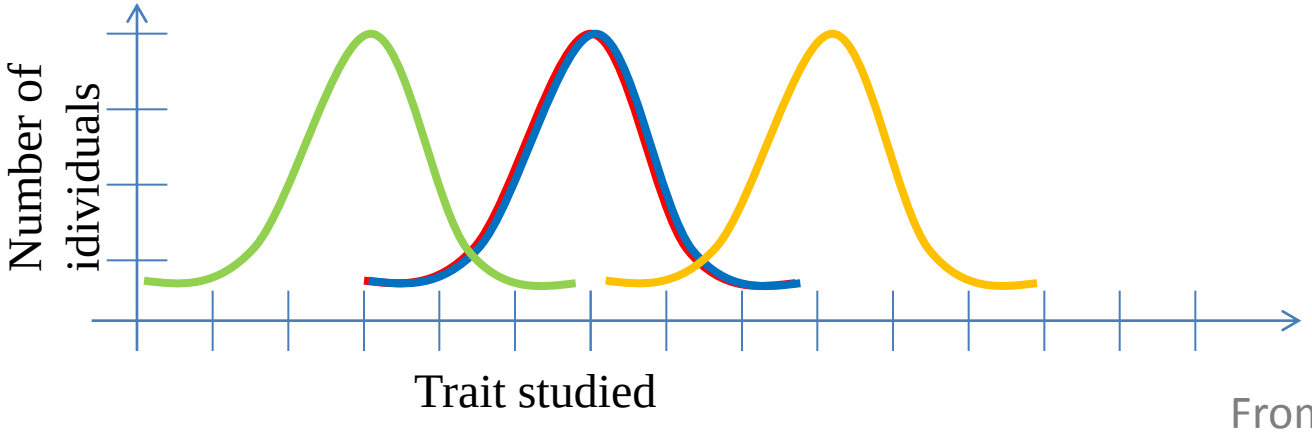
- Ratio biomass produced/ water consumed

# QTL analysis

➲ By using molecular polymorphism




From Loïc Lecunff

# Studies already done on growth under water deficit conditions

- **Quantitative genetic studies on perenial species**
  - *Growth*
    - Chesnut tree (Casasoli *et al.,* 2004)
    - Cotton (Saranga *et al.,* 2004)
    - Willow (Rönnberg-Wästljung *et al.,* 2005 ; Street *et al.,* 2006)
    - Poplar (Montclus et al., 2012)
  - *Water use efficiency*
    - Pine tree, Quercus robur (Brendel et al., 2002; 2008)
    - Grapevine (Marguerit et al., 2012)
- **Some troubles to detect stable QTLs**

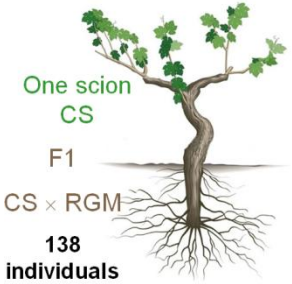
  **Genotype × environment interaction** (Reymond *et al.,* 2003)

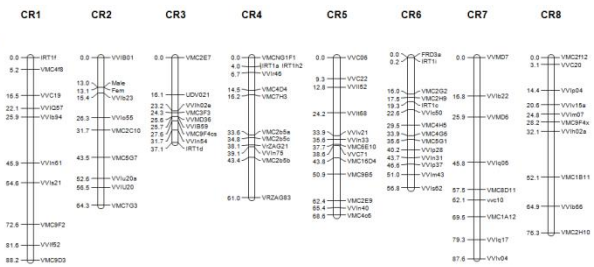
  **Rootstock × scion interaction** (Rives 1971 ; Ollat *et al.,* 2003)

# Experimental design

♀ CS x ♂ RGM

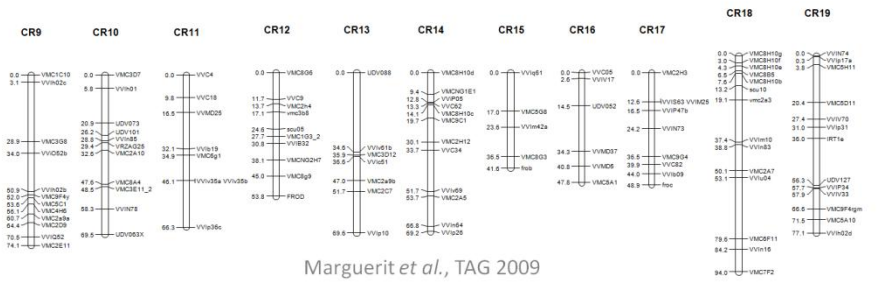
A F1 pedigree population
138 individuals



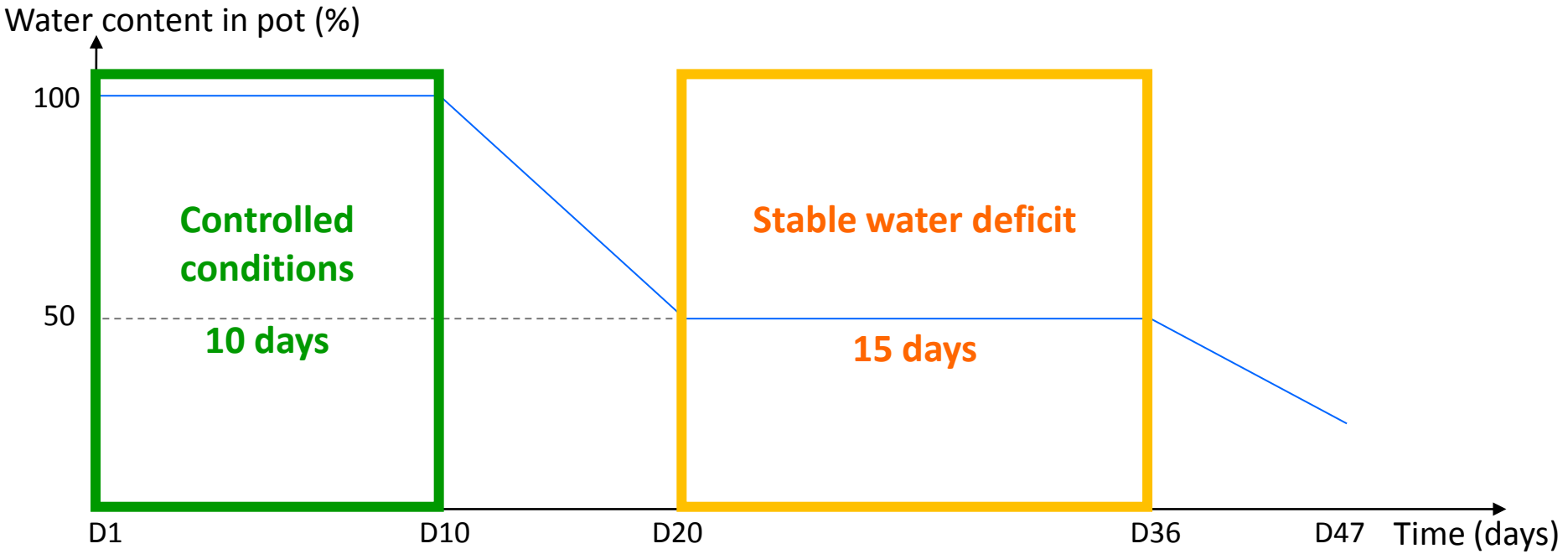

A genetic map

(Marguerit et al., 2009)




Marguerit *et al.*, TAG 2009

# The drought experiment




(Marguerit et al., 2012)

# QTL analysis

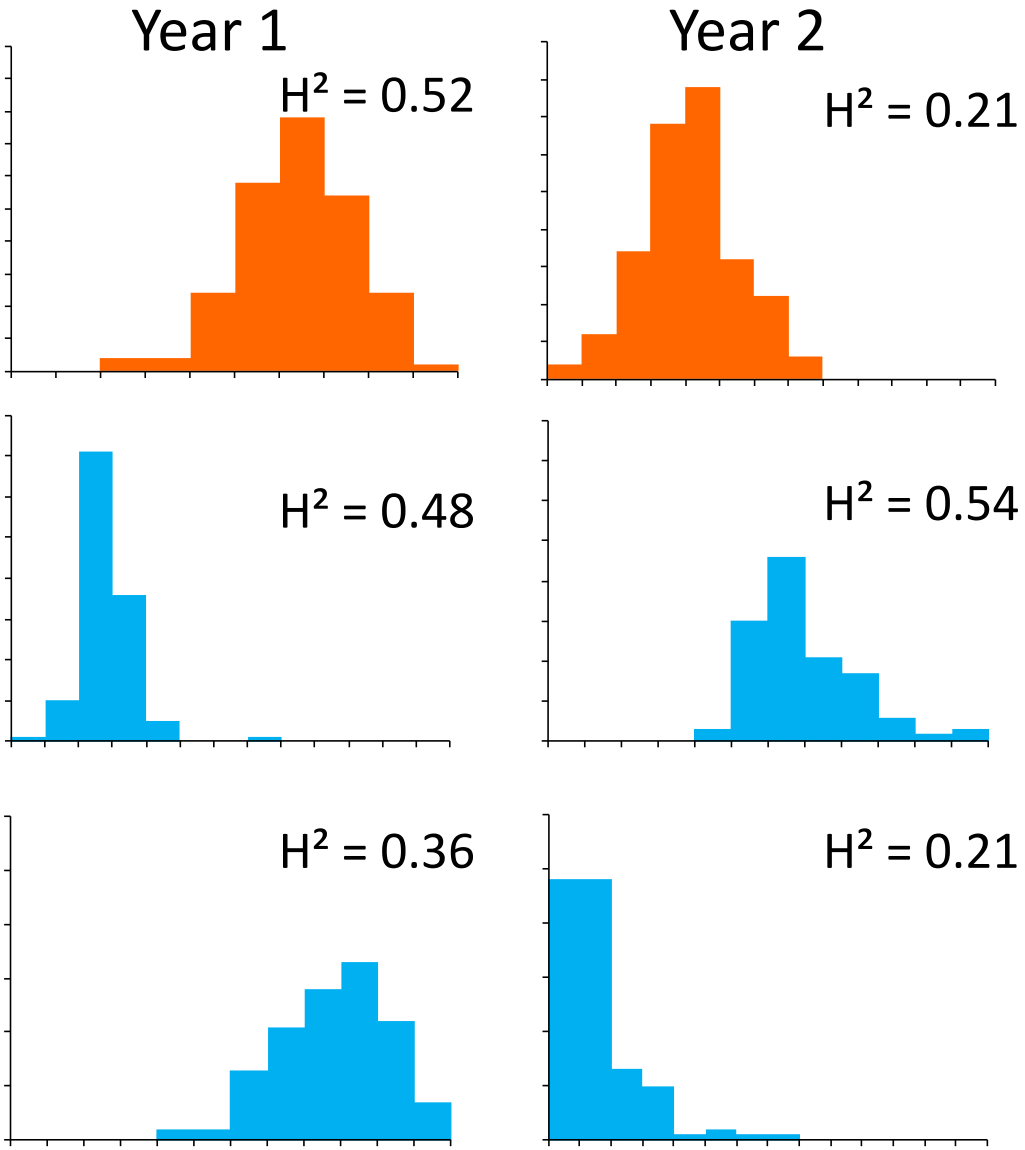
- Traits determined:
  - **Biomass accumulation:** pruning weight, root and shoot dry biomass,
  - **Growth:** shoot length, leaf area
  - **Growth rate:** coefficient of growth responses curve to the sum of degree days
  - **Water use efficiency related traits** : $\delta^{13}C$, ratio biomass produced/ water consumed

MultiQTL

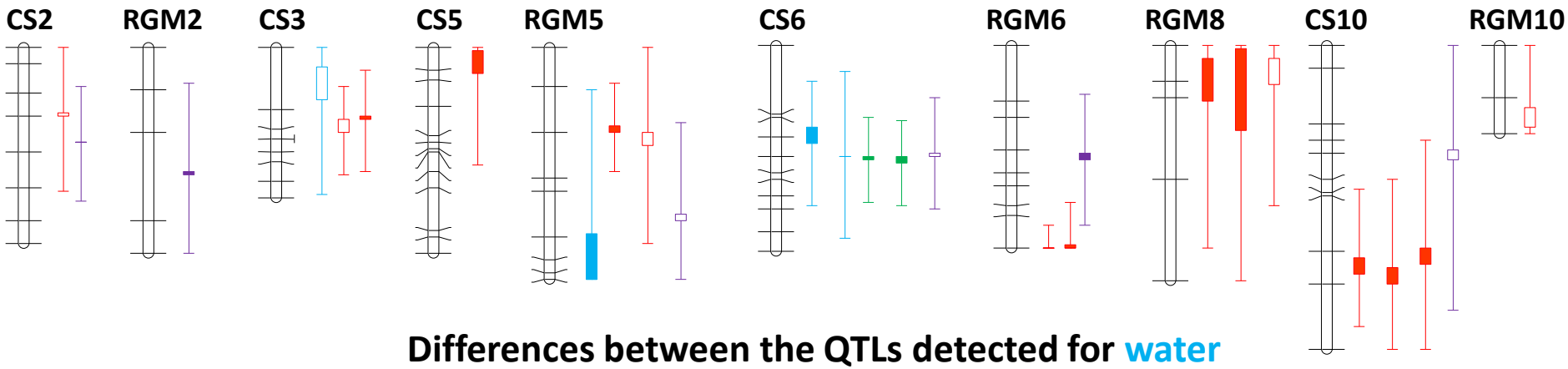
- QTL detection with single year and multi year analysis
  - Significant QTL = QTL significant on the whole genome ($p < 0.05$)

(Members of the Complex Trait Consortium, 2003)

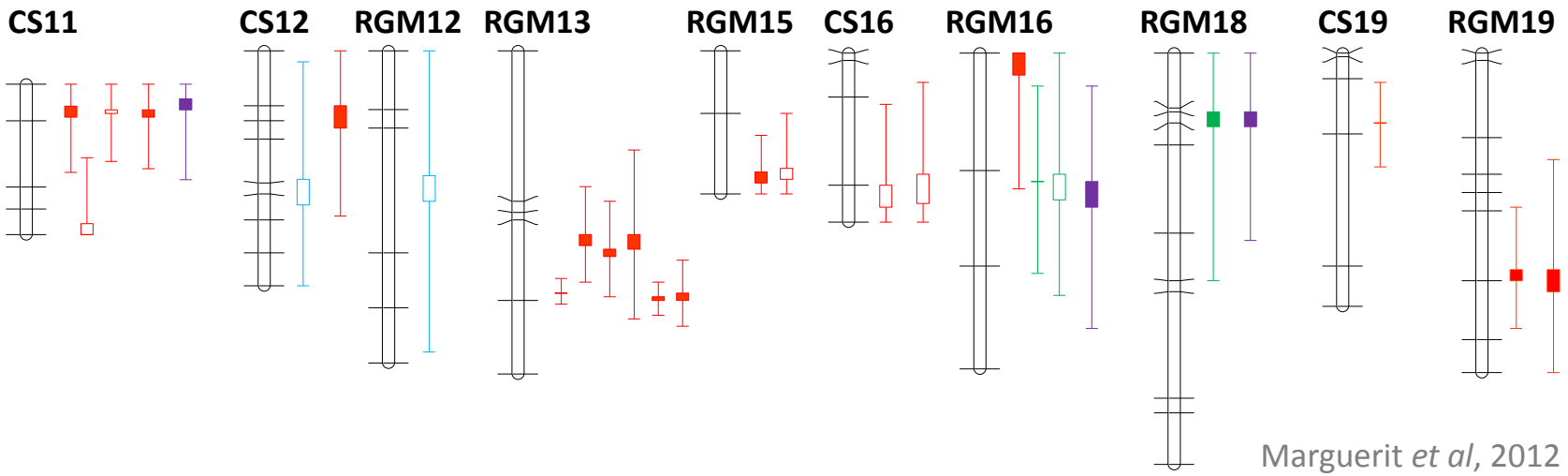
# Genetic variability within the pedigree population



# Partial independance between biomass allocation and water use efficiency genetic architectures




**Differences between the QTLs detected for water use efficiency and biomass accumulation**




Marguerit *et al*, 2012
Marguerit *et al*, in preparation

# Conclusion

- Water use efficiency is not an easy trait to study
- WUE-related traits were mediated exclusively by rootstock

- A genetic control from the rootstock on scion water use efficiency
- Roles of rootstock in water use efficiency :
  - Effect on daytime transpiration
  - Possible effect on night transpiration
  - Effect on water extraction capacity

- Understanding of rootstock effects and drought adaptation processes

In the frame of a breeding programm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Thank you for your attention